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THE SIGNIFICANCE OF PROFESSOR THOMSON'S WORK IN THE DEVELOPMENT OF ELECTRICAL ENGINEERING[1]

By Dr. KARL T. COMPTON

PRESIDENT OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

ANY one with the misapprehension that engineering practise consists in following a set of fixed formulas, rules and specifications will do well to consider that electrical engineering and the art of useful application of electricity has developed almost entirely during the lifetime of Professor Elihu Thomson. The basic scientific discoveries of electromagnetic induction by Faraday and Henry had been made during the decade just preceding his birth, as had the first crude form of telegraph. But generators, motors, transformers, transmission lines, electric meters and regulators, electric lights, telephones, x-rays, electric discharges through high or partial vacuum, lightning protectors, converters, rectifiers, electrical insulators, wireless, radio and all the theory and practise of electrical networks are the product of science and invention since Thomson's birth on March 29, 1853. These things, and the economic problems associated with them, constitute the field of electrical engineering. Some of them Professor Thomson has himself invented, a majority of them owe much of their development to him, and there is scarcely a one on which he has not left his imprint in one way or another. Yet I suspect that he himself would be the first to maintain that we are as yet only at the threshold of the possibilities which are inherent in electricity for the services of man, and that no one would more stoutly advocate the continued endeavor to discover these possibilities and make them effective.

Granted this, it must nevertheless have been a particularly thrilling experience to be connected with the early engineering and industrial developments of electricity, in the early 1880's, when it first became evident that in electricity lay a mighty force whose

[1] Address given on the occasion of the eightieth birthday of Professor Elihu Thomson at the Massachusetts Institute of Technology, March 29, 1933.

potentialities were as yet but dimly imagined, yet which opened up in new directions, week by week, to the eager and talented young men, Edison, Thomson, Rice, Brush, Edgar, and the others.

Inspired by the possibilities which he had come to realize while experimenting with electricity as professor in the Boys' Central High School of Philadelphia, Professor Thomson and his colleague, Professor Houston, formed the Thomson-Houston Company in 1882, at the age of 29. With the able assistance of his pupil, Edwin W. Rice, he then began his long career of industrial and scientific research and its commercial development.

Perhaps Professor Thomson's first great contribution to electrical engineering was his invention in about 1879 of the three-coil dynamo with its automatic regulator and other features, which formed the basis of the first successful electric lighting system. This was put out by the Thomson-Houston Company in the early 1880's, and quickly found its place not only in this country but also in the leading countries of Europe. The machine was entirely automatic in its operation and so adjusted that it could maintain constant regulation in a system of many electric arcs, no difference how many of these arcs might be turned off or on. The need for such a regulator and its general nature were suggested to him by his earliest serious electrical studies, which were on the relation between the current and voltage in an electric arc, and which led him to the discovery that as the current increases the voltage falls—a relation which accounted for the instability of an arc, and pointed out characteristics which an arc dynamo should have.

It is interesting to note that this three-coil dynamo was a direct-current machine provided with a commutator, since in those days direct currents were more readily handled than were alternating currents and had certain advantages for arc-lighting purposes. However, exactly the same machine, simply with different connections, constitutes the three-phase generator which is so important in present-day electric power and was so represented by Professor Thomson in his original patent application. This is one of many cases in which Professor Thomson's ideas were years in advance of the world's readiness for their acceptance and utilization.

About two years later (1881) there was another great invention, that of a magnetically operated lightning arrester. Although this was designed for the particular purpose of protecting his arc-light systems from lightning, it was the invention of a fundamental method of breaking electric circuits, which has found very numerous applications, one of the most important of which was by Professor Thomson himself in the control of electric cars and trains.

The fundamental idea of this was again based upon an accurate knowledge and study of scientific phenomena involved in the discharge of electricity through gases. A transmission line, of course, has to be insulated from the earth by insulators adequate to prevent spark-over at the voltages used. If, however, the line is struck by lightning or an abnormally large electric surge passes through it, a spark may pass around the insulation, and it is a peculiarity of sparks through air that when once the insulation of the air is broken down by a spark there is literally no limit to the amount of current which can flow. Thus these sparks frequently cause serious short circuits.

Professor Thomson's discovery consisted in placing the insulator between the poles of a magnet, with the result that the spark or arc which might be produced was acted on by electrical forces in such a way as to elongate it in the form of a bow which became more and more extended until it finally became so long that it went out. This principle is of just as great importance to-day as ever, and is the foundation of many recently improved schemes for the switching of very large currents.

Again in these very early days and long before the importance of it was realized, Thomson invented the now universally used method of transmitting electric power, stepping it down from a high tension with the aid of a local transformer for consumption. This was set up as a working model at the Franklin Institute in Philadelphia in 1879, a patent was applied for in 1885, and after an unusually strenuous history in the patent office, the fundamental patent for multiple-arc distribution systems with transformers was granted in 1902. During this same time and as an additional safety device for high voltage operation, Thomson patented the procedure of earthing the secondary coil of the transformer, a practise which has now become universal. In passing, I should note here, as an illustration of a notable characteristic of Professor Thomson, that this patent on his advice was dedicated by the General Electric Company to the public from a feeling that no patent or invention which has to do with public safety should in any way be restricted or made unavailable to the people.

In the further development of alternating-current machinery, he invented the constant-current transformer and the inductive regulator in which a movable secondary or primary coil could be adjusted automatically to give constant-current output. Again in the direction of increasing the power capacity of transformers, in 1887–89 he first proposed the use of oil for cooling and for insulation purposes in transformers, and furthermore called attention to the great and deleterious effect of moisture in the oil,

an effect whose full significance students of insulators are only now beginning adequately to realize.

I pass now to two of the most important and characteristic of Professor Thomson's discoveries. The first of these is that process of electrical welding whereby the welded surfaces were fused and united by the heat developed on account of the resistance in the contact between them. This method of welding has come into enormous use in industry and the indications are that it will be even more used in the near future. As examples in widely different fields may be mentioned the welding of seamless metal tubing, the attachment of filaments and other electrodes in incandescent lamps and vacuum tubes, and the fastening together of most of the parts of the new Ford automobile. In the former of these applications, it may be interesting to know that a single manufacturer has manufactured in a single year enough bedstead tubing to reach around the earth.

Professor Thomson was not the first to utilize an arc in welding. The Demeritens patent, which was fundamental, was bought on advice of Professor Thomson by the Thomson Electric Welding Company in the early days, and, had arc welding developed within the life of the patent, that company would have controlled the arc as well as the electric resistance welding art.

Again, one of Professor Thomson's most fundamental discoveries was the principle of dynamical repulsion between a primary and secondary coil. This can be demonstrated by a variety of interesting lecture experiments, most of which were suggested and shown first by Professor Thomson himself. For example, a vertical iron core was wound with a coil through which an alternating current could be passed. The core projected above the coil into a jar of water. Fitting loosely around the core was a second small coil, free to slip up and down the core in the water, and supporting by its terminals an incandescent lamp. When an alternating current was sent through the primary coil, a current was induced in the movable secondary coil which lighted the lamp and at the same time raised the coil, against the force of gravity, high up in the jar of water. This scientific observation was developed by Professor Thomson into an alternating current repulsion motor which is nothing more nor less than our ordinary induction motor, which is in almost universal use for small single-phase motors.

In connection with this discovery you will be interested in the following quotation from the *Electrical World* of May 28, 1887, commenting upon this work.

> It is, as yet, too early to assign to its proper place and limit the part which the alternating current will take in the electric arts. It has started on its career with most rapid strides, and it now only remains to devise means for its accurate measurement, regulation and distribution. Certain it is that Professor Thomson's brilliant paper can not fail to act as a powerful stimulus to those whose attention is now absorbed in the direction indicated, and the fruits of which will soon be noted. We hope that at a later meeting of the Institute Professor Thomson will give to the world his practical results, which he has only hinted at in the present paper.

Professor Thomson was then 34 years of age. These practical results are now seen, for example, in probably a million induction motors in daily use.

During the years 1885–1895 Professor Thomson was busily engaged with the development of electric meters, especially recording watt meters, of which more than 4,000,000 are now in operation, and for this invention Professor Thomson was awarded the Paris Meter Prize of 1890 at a competition held after the exposition of 1889.

As early as 1890 and continued intensively for half a dozen years thereafter were a series of brilliant experiments on high-frequency alternating currents, paving the way for many of the developments in wireless and other high-frequency applications which are being so actively applied at the present time. He constructed the first high-frequency dynamo, operating at frequencies of 30 to 40 times as great as any previously designed, and in connection with experiments with this type of electric power, he designed also the first special high-frequency transformers. While working in this field, he discovered a method of producing still higher frequency alternating current from a direct-current arc, by shunting the arc with inductance and capacitance, thus discovering the method which played such an important rôle in wireless transmission up until its virtual replacement by electronic tube devices only within the past few years. This interesting method of producing alternating currents was actually applied to wireless telegraphy by Poulsen, and is therefore generally known as the Poulsen arc. Also in connection with these high-frequency investigations, he made the important discovery that the insulating power of oils at these high frequencies is very much greater than at the ordinary low commercial frequencies, if this insulating power is measured in terms of the path at which a spark will pass. Just one other item can be mentioned in connection with his high-frequency work, namely, the fact that he discovered and was the first to use the method of tuning electric circuits, which is, of course, absolutely fundamental to modern electrical communication systems. This was done very early in his career while he was still a professor at Boys' Central High School in Philadelphia, and was done in connection with experiments on wireless signaling which

antedate the famous experiments of Hertz by about a dozen years, and, as far as I have been able to ascertain, constitute the first experiments on the propagation of electric waves and wireless signaling, with the sole exception of some experiments conducted still a dozen years previous to his by Joseph Henry in Princeton. These earlier experiments of Henry's were apparently never published.

Immediately upon the announcement of the discovery of Röntgen rays, Professor Thomson began a series of interesting experiments and valuable developments in connection with the x-ray art. The foundation for this work had been laid by previous experiments on electric discharge through gases at low pressures, and led to the first application of stereoscopic methods in Röntgenology only one year after the publication of the Röntgen rays themselves had been announced, and led also to various practical improvements in the design of x-ray tubes, as, for example, the double-focus x-ray tube and a cooled-target tube within less than a year after the discovery of Röntgen rays. In connection with these experiments Professor Thomson also took a lively interest in the physiological effects of x-rays, including x-ray burns, and in the laws governing diffusion of x-ray matter, subjects which have been developed on the one hand to exceedingly important applications in medical therapy, and on the other hand to give some of the most intimate knowledge which we possess of the internal constitution of matter, such as the arrangement of atoms in crystals and molecules, and the arrangement of electrons in atoms.

Things like these, and many more of them, constitute the tangible contributions of Professor Thomson to electrical engineering. His intangible contributions are less easy to talk about, but are none the less real and important. I can not close without mentioning a few of them.

Still quite tangible are his services to engineering education. From his earliest work as a teacher of science in the Boys' High School of Philadelphia, to his many years of service to the Massachusetts Institute of Technology as member of its corporation and executive committee, its acting president during a critical period, a frequent member of the visiting committee of its department of electrical engineering and non-resident professor in that department, he has been a continual inspiration and source of help to students and colleagues.

Rather less tangible is his influence in the many professoinal engineering and scientific bodies of which he is a member. Not only have his scholarly contributions been many and important, but he has consistently been an ideal connecting link between the practical and the theoretical, the commercial and the academic, by his example keeping them from being too narrow and maintaining a generous spirit of mutual appreciation and cooperation.

Still less tangible, but perhaps most important of all have been his inspiration to his thousands of business and research colleagues, his example of enthusiasm, perseverance, ingenuity, unselfishness, love of truth, generosity and broadmindedness.

As I have come to know it, the electrical engineering profession is on a remarkably high plane, both technically and also in general attitude. I believe its debt to men like Professor Thomson for making it a good profession in which to work is at least as important as its debt to him for so much of its basic technical development.

IN HONOR OF PROFESSOR ELIHU THOMSON[1]

By Dr. VANNEVAR BUSH

DEAN OF ENGINEERING AND VICE-PRESIDENT OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THERE are many titles which I might use in presenting to you these greetings on the occasion of your birthday; but I feel sure that that of "Professor" is most welcome to you. It emphasizes an aspect of your accomplishments which I know is close to your heart. Great material changes have followed upon your scientific and engineering accomplishments, and these are visible to all of us in our daily lives. More subtle but none the less lasting is the influence of your many contacts with academic affairs. You have touched and moulded many institutions which are dedicated to the education of youth, and I bring you the felicitations of your colleagues everywhere.

Sixty-three years ago you were a professor in Philadelphia. We take great pride that you are still, and we hope will long be, professor of applied electricity at the Massachusetts Institute of Technology. Through these years your interest in collegiate affairs has been continuous. I need recite but a few instances. In 1890, just as I was born, and when you were thirty-seven, Yale recognized you as a master of arts. Tufts has the distinction of having conferred upon you your first doctorate, that of philosophy. Harvard made you doctor of science, and the University of Pennsyl-

[1] Address given at the dinner to mark the eightieth birthday of Professor Elihu Thomson, March 29, 1933.

vania, doctor of laws. Victoria University reached across the ocean to confer the degree of doctor of science.

Your contacts with educational institutions have been much more than occasional, however. They were bound to be, for your interest in their affairs has always been constructive. I find you, very early, organizing a scientific society, lecturing to audiences in an artisan's night school, at the Franklin Institute, and at many other places. And in later years, you have served on the visiting committees of this institution and of several departments of Harvard University.

Your contacts with the Massachusetts Institute of Technology have been particularly close. It was a fortunate thing for us when your acquaintance with Professor Cross brought you to lecture here fifty years ago on electrical machinery. Since that time we have always felt your presence. For thirty-five years a member of the corporation, and for twenty years on its executive committee, you have guided our steps. One of the most helpful things you have ever done for us was when you were highly instrumental in bringing to the institute the president we all so deeply honor, Dr. Maclaurin. Another act, a small one this time, but one that reminds me of you every time I look out of my window, was when you classified for him the names that appear graven on our buildings. And finally, when he died, you became for two years our acting president and gave of your time and effort to steady us on our feet as we staggered from that blow. And now you are still "Professor" and our colleague.

There has long been, on the part of the layman, an inclination to associate the title "professor" with the pedantic and the cloistered. To fully earn the title it is sometimes popularly supposed that one must cultivate an intense absent-mindedness and a lack of knowledge of the every-day affairs of the world. You have certainly done much to dissipate this idea, and your colleagues rise and call you blessed. That there exist professors who can put up a window-shade while conversing in ordinary language, or who can set the timing of an automobile as a form of recreation, is a fact of the modern world which is still incredible to the laity. That there is one who has hundreds of patents to his name for all sorts of things which very practical men have been very glad to use has given the title a significance which is well added to its dignity. I hope that every farmer who uses a cream separator will realize that it was invented by a professor, for it will do much to counter that persistent fallacy that those who think deeply are necessarily beings apart.

The world progresses only so fast as it learns to pass on its accomplishments from one generation to the next. The material things, those that are of direct utility, machines and structures, can hardly be passed on at all to-day, for obsolescence is much more rapid than deterioration. The written word, the recorded science of yesterday, is here to-day, and we may delve and explore for the thoughts of the pioneer in order that the gains made by those who blaze the path may not be lost to those who follow. But there is a means of transfer of accomplishment which transcends either of these, just as the speed of thought is greater than the working of tools or the reading of words. It is the direct contact between the alert mind of youth and the seasoned and inspiring mind of experience. This is education in its essence. All the paraphernalia of the college, the faculties and curricula, the tall towers and the basement laboratories, have but one purpose, to bring together in an atmosphere of progress the youth and his teacher, and to make it possible for them to work.

It is not by chance that you, who have been scientist, inventor, organizer, engineer, man of business, have been for sixty-odd years professor. It is because that profession holds for you, as it does for us your colleagues, the key to an accomplishment that is more truly satisfying even than the pushing back of the boundaries of science or the application of the fruits thereof to the material benefit of man. There must have been a glorious feeling of triumph when you first watched an electric arc stream out and attenuate in a magnetic field. The satisfaction of electrically making one piece of metal where there were two before was intensified by the realization of what the process would mean in the comforts of life to all. But I venture the thought that these were not as stimulating or as lasting as the satisfaction which was yours when you first caught in the eyes of a youngster that gleam of fire which told you that a spark of your own wisdom had transferred to another mind. The joy of teaching is deep seated in our primary instincts, and there is an immortality more specific than fame.

You have taught us many things of less tangible nature than how to make a transformer yield constant current. You have showed us that a man may be truly a professor and at the same time very practical. And one thing more which I wish to emphasize. You have shown us that a scientist or engineer may be, even in this complex modern world, versatile and yet not superficial. I recall that you were first a professor of chemistry and of mechanics, and you are now professor of applied electricity, and you have been organizer, inventor, man of business, engineer, astronomer, executive, philosopher. In these days, when there is a tendency to specialize so closely, it is well for us to be reminded that the possibilities of being

at once broad and deep did not pass with Leonardo da Vinci or even with Benjamin Franklin. Men of our profession—we teachers—are bound to be impressed with the tendency of youths of strikingly capable minds to become interested in one small corner of science and uninterested in the rest of the world. We can pass by those who, through mental laziness, prefer to be superficially and casually interested in everything. But it is unfortunate when a brilliant and creative mind insists upon living in a modern monastic cell. We feel the results of this tendency keenly, as we find men of affairs wholly untouched by the culture of modern science, and scientists without the leavening of the humanities. One most unfortunate product is the type of engineer who does not realize that, in order to apply the fruits of science for the benefit of mankind, he must not only grasp the principles of science, but must also know the needs and aspirations, the possibilities and the frailties, of those whom he would serve. There are students who may realize this fallacy only when it is too late. To those we would say: "There is one of your professors to whom we would call your attention. He exemplifies that combination of breadth with a definiteness of grasp of the affairs of this world to which we may humbly aspire. He has made significant advances in many diverse branches of engineering, represented by many inventions relating to such things as the uniflow steam engine, the lightning arrester, the cream separator, the electric meter, the resistance welder, x-rays, the automobile muffler, the use of helium in diving, the heat treatment of steels and various chemical processes. He has written of such matters as the nature of comets, the light of the firefly and the aurora. He has organized and guided business and one of the great electrical companies of the world bore his name. He has many, many friends. May some of you follow in his distinguished footsteps that the world may be brighter and more replete with the opportunity which comes with material advance! May you make many friends, as he has, that those who inherit these benefits may know and understand each other better. May you grasp his kindly philosophy, that you may be happy as you create."

I bring you, sir, not only the salutations of your colleagues, but also their heartfelt gratitude that you have dignified and enriched the title of professor, and that we may hail you as friend and colleague.

SCIENTIFIC EVENTS

INDUSTRIAL RESEARCH LABORATORIES

WE learn from Science Service that while over 55 per cent. of the research laboratories serving America's industries have either maintained their staffs of investigators at the same level or actually increased their workers, there has been a decrease of over 12,000 in the staffs of other industrial laboratories in the past three years. However, at least 90 per cent. of the concerns reporting have maintained at least a skeleton research organization. This is shown in a survey just completed by Dr. C. J. West and Miss Callie Hull, of the Research Information Service of the National Research Council.

This year 1,467 laboratories reported 21,464 scientists on their staffs, while in 1930 there were 33,596 scientists on the staffs of 1,420 laboratories. This is taken to mean that at least 10,000 highly trained industrial research scientists are not engaged in scientific research due to the economic depression. The potential value of the lost services of these scientists must run into millions of dollars annually. Some of these scientifically trained workers have been transferred to plant and sales jobs, it is believed.

The 500 laboratories that reported decreases in staff employed 23,783 in 1930 and now have at work only 9,686. The 628 laboratories that reported no change employ 5,268 investigators. In 186 laboratories the staffs were increased from 3,768 in 1930 to 5,338 in 1933. The number of laboratories discontinued during the three-year period between the National Research Council surveys numbered 106 and they employed 775 scientists in 1930. In the course of the survey 153 laboratories now employing 1,172 scientists were included in the survey for the first time. Some of these may be new laboratories, but most are small research organizations that were not discovered in the course of the 1930 survey.

THE FIELD MUSEUM OF NATURAL HISTORY

THE annual report of the director of Field Museum of Natural History to the board of trustees, a book of 141 pages with nine photogravure illustrations, has been published by the Field Museum Press. In this book Director Stephen C. Simms outlines the activities of the museum during the year 1932.

The fact is emphasized that the museum has been able to continue its full service to the public, and has even extended its educational influence to a greater number of persons (attendance in 1932 having been 1,824,202) than in any previous year, despite having, like other endowed institutions, suffered a heavy decline in revenue. With income in 1932 $267,000 less than that in 1931, the museum reduced its expenses

by $273,000 through calling expeditions home, making payroll adjustments, and putting economies in force throughout the institution.

Among contributions to the museum during the year were the following: from Marshall Field, a trustee of the museum, $96,000; from Stanley Field, president of the museum, $35,788; from Mrs. E. Marshall Field, $50,000; from Mrs. Charles H. Schweppe, $18,000; from Mrs. James Nelson Raymond, $3,000; from Frederick H. Rawson, $3,000; from the American Friends of China, Chicago, $1,075; and various sums from Leon Mandel II, Fred Mandel, Jr., William J. Chalmers and Arthur M. Barnhart.

The report gives a full account of the work of the various scientific departments; the educational activities of the James Nelson and Anna Louise Raymond Foundation and the N. W. Harris Public School Extension, which are units of the museum organization for cooperative work with the schools of Chicago; a résumé of new exhibits; of gifts of material received for the collections, lists of the several thousand members of the museum, and other data on the institution's activities.

CENTENARY OF THE BRITISH ENTOMOLOGICAL SOCIETY

THE Entomological Society of London celebrated the centenary of its foundation at meetings held on May 3 and 4 in the rooms of J. G. Children, of the British Museum. According to the London *Times*, the society received a Royal Charter in 1885, and the King became patron of the society in 1914.

On May 3 a general meeting of the society was held in the rooms of the Royal Geographical Society, Kensington Gore, at which delegates from other learned bodies at home and abroad were received and presented addresses. A scientific conversazione was held in the evening in the house at 41, Queen's Gate, which the Entomological Society now shares with the Imperial Institute of Entomology, and fellows brought with them exhibits.

The following day an afternoon conversazione took place for the delegates at the British Museum (Natural History), and an evening reception at Lancaster House was given by the Government, the guests being received by Major Walter Elliot, minister of agriculture. The delegates from abroad were invited to spend the two following days visiting collections and entomological laboratories in the country, including in their tour Whipsnade and Lord Rothschild's collection at Tring.

Professor E. B. Poulton, who was president in 1903–04 and in 1925–26, has been elected president for the centenary year, while the vice-presidents are Dr. H. Eltringham, Dr. K. Jordan and Mr. R. W. Lloyd. Dr. S. A. Neave, assistant director of the Imperial Institute of Entomology, is the honorary secretary. In addition to fellows of the society (now numbering nearly 700) delegates from about 140 learned institutions, universities and museums at home and abroad accepted invitations to be present.

Minute-books in the possession of the society show that an almost continuous history links the present Entomological Society of London with predecessors as far back as 1745, when the Aurelian Society held meetings at the Swan Tavern, 'Change Alley. The present Entomological Society of London occupied rooms in turn at 17, Old Bond Street, at 12, Bedford Row, and as tenants of the Medical Society of London at 11, Chandos Street. The move to 41, Queen's Gate, took place in 1920, and a meeting-room of great beauty, with panelling and decoration copied from the Bromley Room in the Victoria and Albert Museum, was subsequently constructed through the generosity of Mr. R. W. Lloyd and opened in May, 1930, by Dr. Addison.

AWARD OF THE LOUBAT PRIZES

AWARD of the Loubat prize of $1,000 to Dr. Charles O. Paullin, of Washington, D. C., and Dr. John Kirtland Wright, of New York, author and editor, respectively, of the "Atlas of the Historical Geography of the United States," has been announced. The second prize of $400 was awarded to Professor Walter Prescott Webb, of the University of Texas, for "The Great Plains."

The Loubat prizes, instituted in 1893 by a grant of Joseph Florimond, Duc de Loubat, are conferred at the end of every succeeding five-year period for "the best work printed and published in the English language on the history, geography, ethnology, philology or numismatics of North America."

The work of Dr. Paullin and Dr. Wright, issued jointly by the Carnegie Institution and the National Geographic Society in 1932, is described by the Jury of Award as "the first major historical atlas of the United States and probably the most comprehensive study of its kind that has yet been published for any country." The purpose of the atlas is to illustrate cartographically the essential facts of geography and history that "condition and explain" the development of the United States. Presentation will be made formally at Columbia University on Commencement Day, June 6.

Dr. Paullin, formerly a member of the faculties of Johns Hopkins and George Washington Universities, was born at Jamestown, Ohio. He received his bachelor of science degree from Union Christian Col-

lege, Merom, Indiana, in 1893, and pursued graduate studies at Johns Hopkins University until 1895. The doctor of philosophy degree was conferred on him by the University of Chicago in 1904. After lecturing on diplomatic history at the Johns Hopkins University, and on naval history at George Washington University, Dr. Paullin joined the research staff of the Carnegie Institution, Washington.

Dr. Wright, librarian of the American Geographical Society, was born at Cambridge, Massachusetts, and is a graduate of Harvard University, having received his bachelor of arts degree in 1913, his master's in 1914, and his Ph.D. in 1922. He was an instructor in history at Harvard in 1916 and 1917, and assumed his present position in 1920.

The prize-winning work of Professor Webb, issued in 1932 by Ginn and Company, is declared by the jury of award to be an accurate study of what happened in American civilization when, in its westward progress, it emerged from the woods and "essayed life on the Plains." Professor Webb's answer, the jury continued, "explores all the shaping influences of land, climate and rainfall and displays in fascinating detail the innovations forced upon the pioneers of the Great Plains—innovations in weapons, in agricultural methods and utensils, in fencing, in water supply, in law and custom."

Members of the Loubat jury were Dr. Isaiah Bowman, director of the American Geographical Society, chairman; Dr. Arthur M. Schlesinger, professor of history in Harvard University, and Dr. Carl Russell Fish, professor of American history in the University of Wisconsin.

THE NATIONAL ACADEMY OF SCIENCES

AT the closing session of the meeting of the National Academy of Sciences held in Washington on April 24, 25 and 26, the following scientific men were elected to membership: Dr. Oswald Theodore Avery, member, Rockefeller Institute for Medical Research, bacteriology; Harold Delos Babcock, physicist at the Mount Wilson Observatory, physics; Dr. Thomas Barbour, director of the Museum of Comparative Zoology, Harvard University, zoology; Dr. Alphonse Raymond Dochez, professor of medicine, Columbia University, medicine; Dr. Bernard O. Dodge, plant pathologist at the New York Botanical Garden, botany; Dr. Eugene F. DuBois, professor of medicine, Cornell University Medical College, pathological physiology; Dr. Griffith C. Evans, professor of pure mathematics, Rice Institute, mathematics; Bancroft Gherardi, vice-president of the American Telephone and Telegraph Company, New York City, engineering; Dr. Herbert Eugene Ives, physicist, Bell Telephone Laboratories, physics; Dr. W. R. Miles, professor of psychology, Yale University, psychology; Samuel Alfred Mitchell, director of the Leander McCormick Observatory, University of Virginia, astronomy; Dr. Linus Pauling, professor of chemistry, California Institute of Technology, chemistry; Dr. J. F. Ritt, professor of mathematics, Columbia University, mathematics; Dr. H. C. Sherman, Mitchill professor of chemistry, Columbia University, chemistry.

At the same session, Dr. Arthur L. Day, director of the Geophysical Laboratory of the Carnegie Institution of Washington, was elected vice-president, succeeding Dr. David White, of the U. S. Geological Survey, resigned. Dr. J. McKeen Cattell, editor of SCIENCE, and Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, were reelected to membership in the governing council of the academy.

At the dinner given on the evening of April 25 medals were presented to five scientific men for distinguished work:

The Alexander Agassiz Medal for Oceanography was given to Dr. Albert Defant, of the Institute for Oceanography, Berlin, for his studies on atmospheric and oceanic circulation and his notable contributions to theoretical oceanography. The address was made by Dr. Henry B. Bigelow, of Harvard University, director of the Woods Hole Oceanographic Institution, and the medal was received by the German ambassador.

The Public Welfare Medal was awarded to Dr. William H. Park, of New York, for his work as head of the research laboratories of the New York City Department of Health as a pioneer and leader both in research and in the application of scientific discovery to the prevention of disease. The address was made by Dr. Simon Flexner, director of the Rockefeller Institute for Medical Research.

The John J. Carty Medal and Award for the Advancement of Science was awarded before his death to Dr. Carty, in whose honor the medal was established, for his distinguished accomplishments in the field of electrical engineering. Dr. Frank B. Jewett, president of the Bell Telephone Laboratories, a colleague of Dr. Carty, made the address, and the medal was received by his son, Dr. John Russell Carty.

The Henry Draper Medal was presented to Dr. V. M. Slipher, astronomer of the Lowell Observatory, Flagstaff, Arizona, in recognition of his spectroscopic researches. The address was made by Dr. Henry Norris Russell, research professor of astronomy and director of the Princeton University observatory.

The Mary Clark Thompson Medal was given to Dr. Francis Arthur Bather, of Wimbledon, England, for his distinguished services in the fields of paleontology and geology. The British ambassador having been detained by the political situation, the medal was received by Ralph Howard Fowler, of the University of Cambridge.

SCIENTIFIC NOTES AND NEWS

DR. ROSS G. HARRISON, Sterling professor of biology at Yale University, has accepted the invitation of the Royal Society of London to give the Croonian Lecture on June 29.

PROFESSOR NIELS BOHR, of the University of Copenhagen, will give the Graduate School Convocation address at Brown University on June 17, his title being "Explanation in Natural Science."

THE John Fritz Gold Medal, which was awarded last November to Daniel Cowan Jackling, of San Francisco, for "notable industrial achievement in initiating mass production of copper from low-grade ores, through the application of engineering principles," was presented to him at a recent meeting in New York of the American Institute of Mining and Metallurgical Engineers. Dr. Geo. Otis Smith, chairman of the Federal Power Commission, made the principal address.

THE gold medal of the National Institute of Social Sciences will be presented to Clifford W. Beers, who initiated the movement for mental hygiene which led to the establishment of the National Committee for Mental Hygiene, the twenty-fifth anniversary of which will be celebrated in New Haven on May 6. Mr. Beers will also be the guest of honor at a meeting to be held on May 10 at the Twentieth Century Club, Boston, to commemorate the twentieth anniversary of the establishment of the Massachusetts Society for Mental Hygiene and the twenty-fifth anniversary of the movement.

FRANK A. PERRET, director of the new volcanological station at the foot of Mt. Pelée, St. Pierre, Martinique, has been appointed Chevalier de la Légion d'honneur by the French Government.

A CORRESPONDENT of the *Journal* of the American Medical Association states that at a recent meeting of the All-Russian Central Executive Committee the degree of honorary science-worker was awarded to the following physicians: Professors Alexis I. Abrikosov, of the First Moscow Medical Institute, for his scientific work in the field of pathology; Professor Nicolas N. Bourdenko, for his scientific work in neuropathology and medical education; Professor Wladimir I. Wojachek, of the Military Medical Academy, for his studies in otolaryngology; Professor Ivan I. Grekov, of the Second Leningrad Medical Institute, who instructed many scientific workers in the field of surgery; Professor Alexis W. Martynov, of the Moscow First Medical Institute, for his surgical work and teaching, and Professor Basil B. Cramer, for his scientific work in the field of neuropathology.

BY an order of the Committee of Privy Council of Great Britain made after consultation with the Medical Research Council and with the president of the Royal Society, Sir Thomas Lewis, director of the department of clinical research in University College Hospital, London, has been appointed a member of the council in succession to Professor J. J. R. Macleod, of the University of Aberdeen.

LORD DAWSON of Penn was reelected on April 10 as president of the Royal College of Physicians, London.

AT the annual election of the Pennsylvania Academy of Sciences Dr. John C. Johnson, State Teachers College, West Chester, was elected *president;* Dr. S. H. Derickson, Lebanon Valley College, Annville, *vice-president;* Dr. H. W. Thurston, Pennsylvania State College, *treasurer;* Dr. T. L. Guyton, Pennsylvania Department of Agriculture, Harrisburg, *secretary;* Dr. V. Earl Light, Lebanon Valley College, *assistant secretary,* and R. W. Stone, Geological Survey, Harrisburg, *editor.* The annual summer meeting will be held in August at Ohio Pyle. The place of meeting for the tenth annual meeting has not been selected.

THE officers elected for a three-year term by the Wisconsin Academy of Sciences, Arts and Letters at the annual meeting held at Madison, April 7 to 8, include: *President,* Rufus M. Bagg, Lawrence College, Appleton; *Vice-president for the Division of Sciences,* Storrs B. Barrett, Yerkes Observatory; *Vice-presidents—for the Division of Arts,* Anselm M. Keefe, St. Norbert College, West De Pere, *for the Division of Letters,* A. R. Hohlfeld, University of Wisconsin; *Secretary-Treasurer,* H. A. Schuette, University of Wisconsin; *Librarian,* W. M. Smith, University of Wisconsin; *Curator,* C. E. Brown, State Historical Museum.

THE council of the University of Bristol has accepted with regret the resignation as from July 31 of Professor A. J. Sutton Pippard from the chair of civil engineering on his appointment to the London University chair of civil engineering at Imperial College. Professor Pippard is a graduate of the university and returned to fill the chair vacated by Professor Ferrier in 1928.

IN recognition of the work of Dr. Evans in metallurgy, the General Board of the University of Oxford has appointed him assistant director of research in metallurgy, without stipend from the university, for the period during which he holds the Royal Society Armourers' and Brasiers' research fellowship in metallurgy.

LAWRENCE MCHUEY, curator of birds and mammals at the Natural History Museum at San Diego, Cali-

fornia, has been appointed federal inspector of exotic birds and mammals entering the port of San Diego.

THE J. T. Baker Chemical Company Eastern Analytical Research Fellowship for 1933–34 has been awarded to Mr. G. W. Low, Jr., graduate of Princeton University, 1931. Mr. Low will engage in analytical investigations at Princeton.

GERALD ASHLEY WARING, geologist in the U. S. Geological Survey, has returned to Washington after two years spent on a detailed survey of the coal deposits of Alaska.

DR. FORREST SHREVE and Dr. T. D. Mallery, of the Desert Laboratory of the Carnegie Institution, and Dr. Ira L. Wiggins, of Stanford University, recently returned from an expedition to the valleys of the Yaqui and Mayo Rivers in southern Sonora. The transition from desert to thorn-forest was studied, some physiological work was done on *Larrea* and *Encelia,* and nearly 400 plants were collected.

SIR HUBERT WILKINS has sailed on the *Bremen* to take part in the proposed Antarctic flight of Lincoln Ellsworth and Bernt Balchen. Sir Hubert is *en route* to Germany, where he will make preparations for the flight before going on to Cape Town and then to New Zealand, where he will meet the Ellsworth-Balchen expedition.

DR. W. F. G. SWANN, director of the Bartol Research Laboratories of the Franklin Institute at Swarthmore, addressed the institute on April 19, on "The Work of the Bartol Research Foundation."

DR. HENRY E. SIGERIST, formerly director of the Institute of Medicine at the University of Leipzig, who succeeded Dr. William H. Welch as director of the Institute of the History of Medicine of the Johns Hopkins University, delivered an illustrated lecture before the Washington Academy of Sciences on April 20. His subject was "Medicine of the Renaissance."

DR. FLORENCE R. SABIN, member of the Rockefeller Institute for Medical Research, gave on May 2 the first lecture on the foundation established at Goucher College by the Baltimore Association for the Promotion of the University Education of Women. The subject of the lecture was "Cells in Relation to Tuberculosis."

DR. WILLIAM BEEBE, director of the department of tropical research at the New York Zoological Park, will address the Phi Beta Kappa Alumni in New York at the annual meeting on May 10. The title of his lecture will be "Four Hundred Fathoms Down."

MARKUS RENIER, visiting research professor of Lafayette College, an engineer of the Department of Public Works of the British government in Palestine, is giving a series of lectures on mathematical rheology at the John C. Green School of Engineering, Princeton University.

DR. MILTON J. ROSENAU, professor of preventive medicine and hygiene, Harvard Medical School, will give two courses at the summer session of the University of California. One course will deal with epidemiology, the other with public health.

THE eleventh Colloid Symposium, which was scheduled to be held at the University of Wisconsin on June 15, 16 and 17, has been postponed for one year.

THE twenty-first annual meeting of the Eugenics Research Association will be held on June 3 at the American Museum of Natural History, New York City.

THE annual spring meeting of the Association of Consulting Psychologists will be held on May 6 at the University of Pennsylvania.

THE third annual meeting of the Field Conference of Pennsylvania Geologists is to be held at Harrisburg, Pennsylvania, on May 27, 28 and 29 at the invitation of the Pennsylvania Topographic and Geologic Survey. Field trips will include Cornwall Mines, the Triassic and the Paleozoic sections of south-central Pennsylvania.

THE ninth annual field conference of the New York State Geological Association will be held in the New York City region on May 12 and 13. The association will convene at Newburgh, New York, on the morning of Friday, May 12, and will proceed by car through Peekskill to northern New York City; stops will be made at localities displaying the overthrusting of the crystalline rocks of the Highlands northwestward on the younger Paleozoic rocks, and the metasediments of northern New York City will be examined. An evening session will be held at Columbia University. Saturday, May 13, will be devoted to a study of the Triassic rocks west of the Hudson River, and of the glacial features and the serpentine on Staten Island. Further information may be obtained from the secretary, Dr. G. Marshall Kay, Columbia University.

Museum News reports that at the meeting of the American Association which will be held in Chicago in June the dates will articulate with those of other conventions which are attended by museum workers: June 8–10, American Federation of Arts; June 12–14, American Association of Museums; June 14–15, Association of Art Museum Directors; June 15–17, College Art Association; June 19–30, American Association for the Advancement of Science. The sections and chairmen are as follows: Art, Walter H. Siple, Cincinnati; History, Robert W. Bingham, Buffalo;

Science, Charles C. Adams, Albany; Art Technique, Edward W. Forbes, Cambridge; Technical (Science technique), E. L. Judah, Montreal; Superintendents, J. Francis McCabe, Chicago; Education, Mrs. Grace Fisher Ramsey, New York; Public Relations, I. T. Frary, Cleveland; Radio, Chauncey J. Hamlin, Buffalo; College, Carl E. Guthe, Ann Arbor.

THE American Mining Congress will be held in Pittsburgh from May 8 to 12. Discussions will be centered about present problems of the coal industry, these including management, mining methods, safety program, mechanical production, haulage, and coal analyses. A large exhibit will be installed in the William Penn Hotel in Pittsburgh, where most of the manufacturers will display products used by the coal mining industry. J. B. Warriner, president of the American Mining Congress, will lead the sessions held in Pittsburgh, with subchairmen in charge of divisional activities. The Pittsburgh committee is headed by Dr. L. E. Young, vice-president of the Pittsburgh Coal Company.

THE ninety-third annual meeting of the German Society of Naturalists and Physicians will be held in Hannover in 1934. There will be no meeting during the present year.

FOLLOWING the resignation of Dr. James Franck, professor of physics at the University of Göttingen and member of the Kaiser Wilhelm Institute of Physical Chemistry and Electrochemistry at Berlin, the resignations have been received, according to press reports, of Professor Herbert Freundlich, distinguished for his work in colloid chemistry, and of Dr. Michael Polanyi, physicist, vice-directors of the institute. An Associated Press dispatch, dated April 28, states that Professor Hermann Jacobsohn, of the University of Marburg, has committed suicide by throwing himself before a train. It is also reported that Dr. Bernhard Zondek, who has been forced from his professorship of gynecology in the University of Berlin, may be given a position in the University of Stockholm. Dr. Gustav Bucky, for three years director of the Central Röntgen Institute and the cancer department at the Rudolf Virchow Hospital, who was reported early this month to be "on vacation," has also resigned and is now in New York. Dr. Bucky is an American citizen of German-Jewish birth.

IN regard to dismissals of German professors, a correspondent of *The New York Times* writes: "Twenty-six Jewish professors were dismissed from the faculties of the leading Prussian universities on April 25 by Bernhard Rust, Nazi Minister of Culture for that state. This makes a total of forty-two Jewish or Republican savants who have lost their teaching posts at Prussian universities within the month, but it is announced officially that these removals constitute only a first instalment in a general house-cleaning of the German academic groves from what is known, in Nazi parlance, as "alien influence." No fewer than eighteen among the Jewish professors who lost their positions belonged to the faculty of the University of Frankfort-am-Main, while seven were dropped from the University of Göttingen and one from the University of Marburg."

THE seventy-eighth annual exhibition of the Royal Photographic Society of Great Britain is to be held in London from September 9 to October 7, inclusive. It is requested that all entries for the technical section from residents of the United States be sent to Dr. Walter Clark, Eastman Kodak Research Laboratories, Rochester, New York. Exhibits should be mounted but not framed, and should reach Dr. Clark not later than June 20. Exhibits for Section III may consist of photographs or transparencies related to the following subjects: natural history, photomicrography, radiography, astronomical and aerial photography, stereoscopy, survey and record work, press and theatrical photography, meteorological, geological and metallurgical applications of photography and useful photographic devices. It is hoped that a generous contribution will be made in order to maintain the high standard set by American contributors to the technical section in previous years. Entry forms may be obtained on application to Dr. Clark. There is no fee.

DURING the past fall and winter the Bacteriological Laboratories at the Pennsylvania State College have been entirely remodeled and reequipped and have been used during the first semester. Specially designed laboratory desks have been installed. Rolling doors make it possible to divide the larger laboratory with ample accommodations for a section of fifty students into two laboratories for smaller groups when desirable. An important item of new equipment is the constant temperature room (37° C.) which affords sufficient space for incubation of class cultures. The facilities now provide excellent working conditions for 280 students registered in the division of bacteriology.

IN connection with the commemoration of the one hundred and ninetieth birthday of Thomas Jefferson, founder of the University of Virginia, presentation to the university was made of a ten-inch photographic telescope of 45-inch focal length from Mount Wilson Observatory. The telescope is to be used by Dr. S. A. Mitchell, director of the McCormick Observatory, in photographing 18,000 stars to determine their proper motions. Funds to provide a complete new mounting have been provided by the Carnegie Institution of Washington.

FRANK A. WARDLAW and his son, Frank A. Wardlaw, Jr., have recently presented to the U. S. National Museum the only cast now known to exist from a life mask of Thomas A. Edison. The mask was made in 1878, the year of the invention of the phonograph and the year before the invention of the incandescent lamp. As this was the only mask of Edison ever made, it will be of value as a record. The same donors presented original Edison lamps of the first types of paper filament and bamboo filament lamps, a galvanometer used by Joseph Henry, and several models of locomotives and marine engines.

THE executive committee of the sixth International Congress for Industrial Diseases and Accidents, held at Geneva last year, has instituted a prize of 1,000 Swiss francs for the best essay on the estimation of the consequences of an industrial accident. The typescript of the essay, which may be written in English, French, German or Italian, should be sent to the general secretary of the congress, Geneva, before December 31, 1934.

AT a recent meeting of the American Institute of Nutrition—Dr. H. C. Sherman, president, and Dr. John R. Murlin, secretary-treasurer—*The Journal of Nutrition,* owned by the American Institute of Nutrition, was transferred to The Wistar Institute. Beginning in January, 1934, this journal will be published by the institute under the same editorial management. Announcement of an increase in the number of yearly issues will be made later. The acquisition of *The Journal of Nutrition* is the first step in the creation of a department of nutrition at The Wistar Institute.

THE return of a permanent American delegate to the International Institute of Agriculture at Rome is probable as the result of action by the Senate Foreign Relations Committee, which has approved a bill by Senator Hiram Johnson, of California, to finance representation at a cost of $48,500 a year. The institute is the nucleus for world planning in crop production. Seventy-four nations participate and America had a permanent delegate at the institute up until four years ago.

THE New York Botanical Garden is now conducting a school for gardeners modeled on those of Kew and Edinburgh. In the past the gardening profession in the United States has been recruited almost entirely from Europe. Student-gardeners are temporary employees remaining at the garden for two years. During the day-time they perform the duties of gardener, being moved as opportunity permits from one department to another to broaden their experience. They attend a two-year course of evening lectures, including such subjects as general and systematic botany, physics and chemistry, soils and fertilizers, plant pathology, entomology, genetics and plant breeding. They also attend demonstrations by the staff and visit other gardens. On satisfactory completion of the two years course a certificate is awarded, also a year's extension of employment at the garden during which time the student is expected to seek employment elsewhere. Appointment as student-gardener is limited to those prepared to do the work without remuneration. The New York Botanical Garden, in cooperation with the Horticultural Society of New York and the National Association of Gardeners, is also conducting a course for professional gardeners in the basic sciences underlying gardening practise.

DISCUSSION

THE CRISIS IN SCIENTIFIC RESEARCH AND THE WAY OUT

WE find ourselves, to-day, faced with a crisis in scientific research, especially in biology and medicine. Professor Krogh has already referred to it at the Thirteenth International Congress of Physiology, held at Boston in 1929.

The causes of this difficulty would seem to lie in a discrepancy between the efforts and the results of research work. The effects of collective scientific endeavor are to-day quantitatively so vast that the possibility of surveying and applying them with complete assurance and certainty becomes ever more remote. From this results a constant increase in specialization; one perceives the various connections less and less clearly, the great clear directing lines and historical points of view tending to disappear. Or, one is obliged to undertake a quite incredible amount of labor, in fact, to devote one's entire life, so to speak, to the subject, without even being certain that the results will prove worth the trouble.

This often only half perceived, almost unconsciously felt, recognition discourages many young scientists so that they turn more willingly towards those forms of activity which promise more practical results, and this constitutes the chief danger to scientific research and its traditions.

The principal cause of all this lies, in my opinion, in the fact that in the technique of publication and survey of scientific results, in the method of mental and scientific synthesis, the old established customs still hold sway, but these are no longer suited to the pace and necessities of our time. We are, to-day, accustomed to the scientific organization of work in every sphere of industry, commerce and administration, one may even say in politics and political propa-

ganda. Only in the realm of science one fails to trace any kind of scientific organization worthy of the importance of science; and in this way much time, energy and economy of means is wasted.

This is especially conspicuous in the production of scientific literature. Science, whilst it is one and international, appears in publications in more than twenty languages, in hundreds of magazines, in thousands, even tens of thousands of pamphlets, in a year. The themes of research work are left mostly to chance, thousands of problems are worked up without any logical discrimination, without intrinsic power, often occasioned by purely external circumstances, for reasons which have nothing to do with the research itself. And these millions of pages are poured out over us like a flood, they cover and swamp us, they inundate us so that we stand continually in a despairing struggle to keep our heads above this sea of papers.

The way out of this chaos is the same as that taken by economics and by the state, namely, rationalization or so-called scientific management. One need not think that through rationalization intuition, the creative faculty, will be suppressed; on the contrary, it will then first obtain a real facility for its awakening, and will then first be able to develop itself satisfactorily. The less energy required to be expended on overcoming difficulties, the more there will be for creation, for invention, and the higher will be the quality of its output.

I have tried for some years to apply to the realm of science the principles of scientific management in industry, administration and politics, and have worked out a system for the means of rationalizing the scientific institutes for research activities and for the collective scientific institutions.

The whole refers to the following system of subjects:

I. Scientific laboratory management:
   (1) Administration of scientific institutes.
   (2) Application of specific scientific activities:
      Practical arrangements.
      Economy of time.
II. Work of research-workers:
   (1) Physical and psychic hygiene of mental work.
   (2) Systematic method in research, especially time- and plan-schedules.
   (3) Application of the card system for collecting scientific data and ideas.
III. Collective scientific activities:
   (1) Congresses—their organization and general plan of research.
   (2) Scientific literature—systematization of periodicals, libraries, reports, scientific treatises, schedules and card indices.
   (3) Scientific language and standardization of expert expressions.

I suggest that an International Committee might consider these problems systematically and make definite propositions.

SERGEI TSCHACHOTIN
KAISER WILHELM INSTITUT FÜR
MEDIZINISCHE FORSCHUNG
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COOPERATION AMONG AMERICAN ZOOLOGISTS TOWARD A COMPENDIUM OF CULTURE METHODS FOR INVERTEBRATE ANIMALS

AT the Atlantic City meeting of the American Association for the Advancement of Science, this matter again came up. Vice-president Zeleny, chairman of Section F—Zoology, appointed as a committee to consider it Dr. Frank E. Lutz, of the American Museum of Natural History, Dr. Paul S. Welch, of the University of Michigan, and Dr. J. G. Needham, of Cornell University.

At the present time there is difficulty in finding information about culture methods. Much more experience has been gained by individuals than has ever been made available through publication. Much also undoubtedly exists in papers whose titles give no clue of its presence. Such information if gathered together and made available to the many whose work nowadays demands the use of living materials in continuous supply would be a great aid to biological research.

The committee has found a very general feeling of need for such a compendium and is proceeding with plans for it. Its plans are as yet wholly tentative. A book is contemplated, to contain the information that is needed by the one who is trying to rear and maintain cultures. It is proposed to have a short introductory chapter on general principles of management, with the main body of the book made up of signed articles, volunteered by individual workers and based on their own practical experience.

It is hoped that for at least one species of each considerable group of invertebrates there may be included a fairly complete account of maintenance requirements, covering collecting methods and devices, cages and breeding quarters, plans for feeding and watering, cleaning and aerating quarters, breeding management, and all else that enters into the maintenance of the species through successive generations. Such full accounts, however, will be few, and less comprehensive items will be welcome.

The committee reserves the right to condense and to combine where necessary to avoid duplication. An effort will be made to include bibliographical refer-

ences to all the more important relevant published material; also summaries and cross-references to aid in finding things.

The scope proposed is North American invertebrates. It goes without saying that Apis and Bombyx are not to be discussed beyond laboratory usages, since their culture has long passed the stage of pioneering that we are to record.

This call goes out to all American zoologists. Let any one who has tested out a reliable method of culture maintenance, or any device that he has found to be particularly useful to that end, write it up and submit it for a place in this book to any member of the committee.

JAMES G. NEEDHAM,
Chairman

CORNELL UNIVERSITY

REVERSAL OF THE PINHOLE IMAGE

IT was my good fortune to be associated with Dr. Oliver J. Lee, director of Dearborn Observatory, in a problem he investigated at the time of the solar eclipse in August, 1932. He wished to obtain information regarding temperature changes produced by the moon's shadow at various altitudes. For elevations of 700, 3,000 and 10,000 feet, this information was furnished by recording meteorographs carried by airplanes, which cruised at constant altitudes in circles about a mile in radius. Lieutenant Baker and I were in the highest plane, which stayed at 10,400 feet most of the time, but rose to 15,000 feet for a while. The report of the observations which I made to Dr. Lee that evening included one phenomenon which I have not seen described by any of the observers who were in airplanes during the eclipse.

For about fifteen minutes preceding totality, while the solar crescent was very narrow, whenever I looked where the shadow of the airplane would have been cast on the clouds more than a mile below, I saw a halo about five degrees in diameter, red on the outside, yellowish on the inner side, with a dark, shadow-like crescent at its center. The angular diameter of the shadow crescent was the same as that of the solar crescent. The thickness at the middle was somewhat greater. What attracted my attention particularly was the fact that the cusps of this shadow crescent pointed eastward, while those of the solar crescent pointed westward. After totality the whole appearance was repeated, except that the cusps of both crescents were reversed in direction.

It was a phenomenon similar to that seen by Edwin Edser in England during the partial eclipse of 1912 and described by him in *Nature* for May 2 of that year. It was the reverse of the familiar pinhole image. A huge screen with a relatively small hole at the position of the airplane would have caused a bright, inverted crescent against a dark background on the clouds, crescent image and solar crescent having the same angular dimensions as seen from the screen. Interchanging screen and hole would interchange image and background, giving the dark crescent which I saw on the bright clouds.

I have repeated, with some modifications, the experiment Edser described. A piece of ground glass close to the condenser of a stereopticon was nearly covered with a circular disk of black paper, leaving only a bright, narrow crescent exposed. The objective of the lantern was removed. A screen with a small hole placed ten feet from the lantern produced a pinhole image on the crescent on the wall an equal distance from the screen. Then a brass ball about the size of the hole was used in place of the screen and a dark, shadow-like crescent appeared on the wall, corresponding exactly to what I saw on the clouds. A small square of black paper substituted for the ball gave the same dark crescent. A little airplane made of black paper also produced the same result. The shadow crescent was independent of the shape of the obstacle, as a pinhole image is independent of the shape of the pinhole, provided obstacle or hole is small enough in comparison with the object. As stated by Edser, in order to obtain the shadow image, the screen must be beyond the apex of the umbra of the shadow cast by the obstacle.

ERNEST C. BRYANT

MIDDLEBURY COLLEGE

THE ADRENAL GLANDS IN AN EDITOR'S OFFICE

A DISTINGUISHED physiologist wrote to the editor of SCIENCE on April 14:

> At the recent meetings of the American Physiological Society in Cincinnati Dr. Britton of the University of Virginia made the statement in open meeting that SCIENCE had published an article on the adrenals by Professor Swingle of Princeton University, the publication of which was paid for by Professor Swingle, and that the pages of SCIENCE have been subsequently closed to Professor Britton and possibly others on the subject of Professor Swingle's original paper or article. If true, this appears to me both a curious and serious situation. I had the understanding that SCIENCE was an organ of the American Association for the Advancement of Science. If scientific articles published in SCIENCE are paid for by authors, that fact should be stated, it seems to me, in connection with the article as it appears in SCIENCE, because otherwise we appear to be in danger of under-cover paid propaganda.

A distinguished physicist wrote on April 19:

> From a number of influential and reputable sources, I have run into a considerable amount of irritation over the article by Swingle, Pfiffner, Vars, Bott, and Parkins

in SCIENCE for January 13. This irritation is on the following grounds: First, that the article implies that the discoveries there reported were made by the authors; second, that the material was rushed to publication through a subsidiary of [subsidy to] SCIENCE; and third, that replies to this article by recognized leaders in the field have either not been accepted or have not been acknowledged.

I admit that the field is entirely outside my own knowledge. Nevertheless, I am assured by men who are the leaders of similar work at the Harvard Medical School and in Massachusetts hospitals that every one of the 12 points published by Swingle, et al, had been published by others, as indicated in part in the enclosed bibliography. I am further informed that this is not the first instance in which Swingle has been in a similar position.

Under these circumstances, therefore, I can not but feel that this incident has reacted unfavorably to the Association and in particular, will be a handicap to the cooperation which we hoped to secure next winter.

The letter from the physiologist was sent to Professor Britton with the following request:

Please be so kind as to let me know whether Professor ——— reports correctly what you said at the meeting of the American Physiological Society. In case he does not state correctly what you said, please let me know what this was.

In his reply Professor Britton wrote:

In prefacing my paper at Cincinnati, since Swingle coming just before me had again neglected to recognize the earlier work of others, I remarked that a recent situation which had come up in connection with the adrenal controversy should perhaps be aired at that time; that Swingle and his associates had recently published an article on a circulatory theory of cortico-adrenal function in which they had stated that all other theories were practically valueless, and gave no reference at all to the previous theories of others, although the paper had been greatly extended over several pages; that the article had been paid for apparently out of special research funds as stated in their foot-note; that other workers in the field (excepting Freeman's partial reply, of course) wishing to reply to the article found that publication could not be secured; that we ourselves could not at first get a reply published on offering to pay for it, but that eventually a short article had been accepted by the journal; and further, that subsidizing or paying for research publications set up a very unfortunate precedent, to say the least. Later, in question time, I asked Swingle if he would mind telling *why* he found it necessary to pay for science publications, and he declined to answer. To my knowledge, this is all I said on the subject.

The facts of the case are these. Professor E. G. Conklin, of Princeton University, wrote (he permits the quotation) on December 22:

I am sending you herewith a manuscript by Professor Swingle and his associates on the physiological activity of the adrenal cortex. I think that this is an extraordinarily important discovery, comparable in many ways to the discovery of insulin, and likely to be of very great service in medicine and surgery.

Professor Swingle had written:

The contents of this paper should be placed before biologists and medical men at the earliest opportunity since there can be no question but that the adrenal cortical hormone is specific in the treatment of surgical and traumatic shock. This form of shock costs the lives of thousands of people yearly and now that the cortical hormone is available for use, it seems a pity that the facts should not be made known and lives saved as speedily as possible.

To Professor Conklin the editor of SCIENCE replied:

I am pleased to learn of the important work of Professor Swingle and also that you and he regard SCIENCE as the best place of publication. As you know, we can not under ordinary circumstances print longer research articles in SCIENCE. . . . The Physical Society has adopted a plan, which is also used in connection with other journals and will I dare say become general in the future, of making the cost of publication part of the cost of the research. . . . If SCIENCE could be enlarged to the extent of the length of the paper it could be printed at once, it being stated that the cost of printing had been defrayed by the institution from which it came. However, this is something that has never been done and I suppose that it is not worth while to take up the possibility at the present time.

After conversation with Professor Conklin at the Atlantic City meeting of the American Association, the editor wrote to him on January 7 as follows:

I have been a good deal bothered about Professor Swingle's article. The journals that I edit have not charged for illustrations, tables or proof alterations, and it is a very considerable departure from long usage to enlarge the journal and charge the cost to the author or institution. Scientific journals, however, seem to be coming to this policy, even when the journal is not enlarged for the purpose of prompt publication, and I expect that it will be generally adopted.

In the case of Professor Swingle's article, it is not only the question of the cost, though under existing conditions that is somewhat serious, but of giving precedence to a long article over the other articles that we have been compelled to hold for a considerable time and especially over the addresses and other material presented at Atlantic City to which we aim in January and February to give most of the space in SCIENCE.

The situation could be explained by a footnote to the effect that SCIENCE had been enlarged to publish this article, the cost having been defrayed by the Macy Foundation or the Princeton Laboratory, as the case may be. On the whole, therefore, though not without reluctance, I shall accept Professor Swingle's offer.

After the publication of Professor Swingle's article three criticisms were received. One of them, abusive and probably libelous, was returned; one by Dr. Norman E. Freeman was promptly printed; the third, by Dr. Britton, was too long for publication in SCIENCE, but a shorter reply was published. After this had been accepted Professor Britton wrote: "Let me again assure you of my gratitude in granting this privilege of reply in your much-esteemed journal." A counter reply by Professor Swingle containing new data was not accepted, though he was informed that a short reply would be.

Professor Britton has published within the last two years five articles in SCIENCE. Indeed the adrenal glands and the whole field of chemical physiology have received, not more attention than their importance deserves, but more space than has been given to other subjects equally important. Now it is necessary to print more words (it costs three cents each to print a word in SCIENCE) on the adrenals; but that and the troubles of an editor are obviously small matters compared with the saving of thousands of lives (see above).

J. MCKEEN CATTELL

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A NEW FORM OF CENTRIFUGE-MICROSCOPE FOR SIMULTANEOUS OBSERVATION OF CONTROL AND EXPERIMENTAL MATERIAL

IN centrifuge studies on the effect of substances on the viscosity or the tension at the surface of living cells, comparison of experimental conditions with control conditions is a necessity. This can be accomplished by a slight modification of the centrifuge-microscopes[1] previously described, which very greatly adds to the convenience and usefulness of the instruments. In the same field of view a perfect image of control and experimental material side by side can be obtained for any power of the microscopes (except oil immersion objectives) and for any rate of rotation that will not shatter the materials of which the instrument is made. Adaptation to the Beams air turbine is possible.[2]

As illustrated in Fig. 1 the device is a special head in the form of a bar, fitting on the ½ inch shaft (A) of a high speed electric motor. At the two ends of the bar are depressions for the special slides S, S[1], which hold the living cells, two microscope objective systems mounted horizontally, and small right angle reflecting prisms to reflect the images to the axis of rotation. Here two ½ inch right angle prisms ¼ inch wide are mounted facing in opposite directions, so as to reflect from both ends of the bar vertically to the stationary ocular (Oc.).

If the lights (L, L′) are incandescent filaments whose images are thrown on the slides parallel to a radius of rotation, the distance of S and S′ to the axis of rotation must differ by 3 to 5 mm, so that S will not be illuminated by L′ and *vice versa*. Since

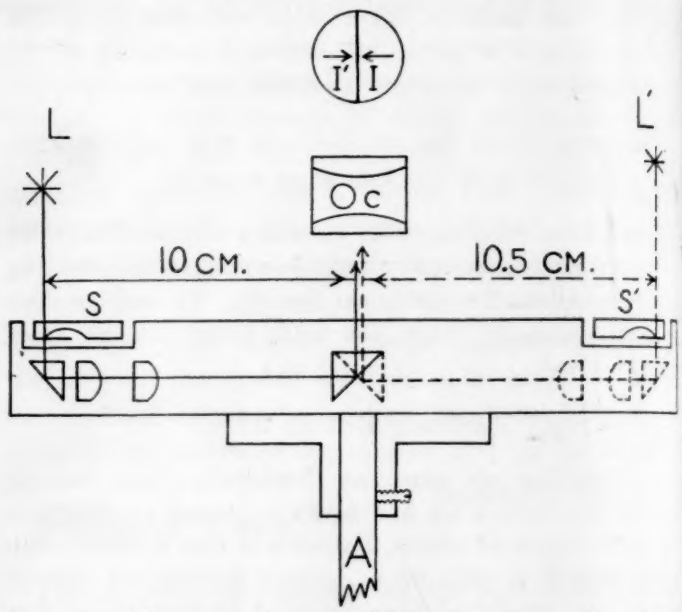

FIG. 1. Diagram of centrifuge-microscope for simultaneous observation of control and experimental material.

the radius of rotation may be 100 mm, this makes a difference of only 3 to 5 per cent. in the centrifugal force on the two slides. The image of material in S′ appears in the left field of the ocular, I′, and the image of material in S appears in the right field, I, the direction of the centrifugal force being indicated by arrows. For successive observation of S and S′, only one light need be used, say L. It is moved 5 mm further from the axis for observation of S′ and back again for observation of S.

If a high voltage condenser discharge in Hg. vapor is used as the source of illumination, L and L′, the distance of S and S′ from the axis may be exactly the same, but the contact surfaces which set off the lamps are arranged at different radial distances from the axis, so that lamp L discharges only when over S and lamp L′ only when over S′. The mercury discharge lamp gives a clearer image over the whole field of view, but necessitates a more complicated accessory mechanism.

[1] E. N. Harvey and A. L. Loomis, SCIENCE, 72: 42, 1930; E. N. Harvey, *Jour. Franklin Inst.*, 214: 1, 1932. I express my sincere thanks to Mr. Alfred L. Loomis for the generous hospitality of his laboratory at Tuxedo Park, N. Y., where the new head was made. The Bausch and Lomb Optical Company will place the standard centrifuge-microscope on the market.

[2] J. W. Beams, SCIENCE, 74: 44, 1931; E. N. Harvey, SCIENCE, 75: 267, 1932.

In this manner the remarkable difference in behavior under the influence of centrifugal force of unfertilized and just fertilized sea-urchin eggs can be observed, and quantitative comparison made of the effect of any substance on the viscosity or form of living cells.

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THE AGITATION OF MATERIAL IN AERATED WATER

IN a recent issue,[1] McCutcheon described an apparatus for circulating and aerating material. The purpose of this note is to describe an arrangement that has been found particularly useful for difficult material, and is successful in a number of cases where other methods have not been entirely satisfactory.

It consists of a circular flat-sided flask (a standard Kolle culture flask serves admirably) filled with water, into which is inserted a glass tube bent and connected with a compressed air outlet.

The bubbles of air, rising at one side of the flask, set up a circular motion in the water, the rapidity of which can be adjusted at will by controlling the stream of air, so as to keep the material continuously circulating.

The apparatus is especially useful when the shape or size of the objects circulated renders them likely to become tangled or lodged against obstructions in their path. The smooth, circular motion, with a minimum of subsidiary vortices makes for a very efficient utilization of the air current. A relatively small amount of air is sufficient to keep light objects submerged and circulating, and objects with a specific gravity considerably greater than water circulate freely.

The use of a filter pump to supply the air current is feasible if the joints of the apparatus be made airtight.

The addition of two siphons, with their outer ends immersed below water surfaces of properly adjusted height, will provide for a gradual change of water in the flask, and convert it into an efficient washing apparatus.

H. B. SIFTON

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SPECIAL ARTICLES

THE ATOMIC WEIGHT OF LEAD FROM KATANGA PITCHBLENDE

THROUGH Professor A. C. Lane, chairman of the Committee of the National Research Council on the Measurement of Geologic Time, we have recently received a fine specimen of Katanga pitchblende, a gift from Radium Belge. Petrographic examination by Professors Lindgren and Newhouse, of the Massachusetts Institute of Technology, showed the black base to be permeated with microscopic veins of yellow material which Davis has already found to be readily soluble in dilute hydrochloric acid. Extraction of the very finely powdered material with dilute hydrochloric acid removed 22.8 per cent. of the original. Approximate analysis of the residual black pitchblende and of the extract yielded the following percentages of uranium and lead. Other analysts have found similar material to be nearly if not quite free from thorium.

	Per cent. U	Per cent. Pb	Pb/U
Pitchblende	74.9	6.7	0.089
Extract	58.5	8.4	0.144
Whole	71.2	7.1	0.100

Lead was extracted from both portions and was purified chiefly by many crystallizations as nitrate in quartz and as chloride in quartz and platinum. Next it was twice distilled in dry hydrogen chloride, and finally it was fused in nitrogen containing hydrogen chloride in a weighed quartz boat.

Analysis of the chloride was effected by solution and comparison with a solution of nearly equivalent quantity of pure silver. The end point of the comparison was found by the equal opalescence method with the aid of hundredth normal silver and chloride solutions and a nephelometer. For comparison, samples of chloride similarly purified were prepared from common lead (Coeur d'Alene) and from Bedford cyrtolite[1] and analyzed.

The result for common lead agrees closely with that commonly accepted (207.22) and that from Bedford cyrtolite with the value previously found by ourselves (205.92). The varieties from Katanga pitchblende both apparently possess atomic weights appreciably lower than that found by Hönigschmid and Birckenbach,[2] 206.05, with lead extracted from secondary minerals associated with Katanga pitchblende. If the original untreated pitchblende is considered as a whole the average atomic weight of the lead is 205.99. Aston[3] has found Katanga lead to be com-

[1] SCIENCE, November 4, 1932.

[1] See Baxter and Alter, SCIENCE, 76: 524, 1932.
[2] Ber. 56: 1837, 1923.
[3] *Nature*, 129: 649, 1932.

THE ATOMIC WEIGHT OF LEAD

Katanga Pitchblende

Wt. of $PbCl_2$ in vacuum g.	Wt. of Ag in vacuum g.	Ratio $PbCl_2$: 2Ag	At. wt. of Pb.
4.57229	3.56261	1.28341	206.00
6.20083	4.83143	1.28344	206.00
4.45462	3.47094	1.28340	205.99
	Average	1.28342	206.00
	Katanga Pitchblende Extract		
2.62575	2.04615	1.28326	205.96
3.75342	2.92474	1.28333	205.98
3.28347	2.55867	1.28327	205.96
3.19222	2.48745	1.28333	205.98
	Average	1.28330	205.97
	Bedford Cyrtolite		
0.59044	0.46015	1.28315	205.94
	Common Lead		
2.56818	1.99234	1.28903	207.21
4.34481	3.37050	1.28907	207.22
	Average	1.28905	207.21

posed of the isotopes Pb^{206} and Pb^{207} in the proportions of 14 to 1. From this evidence the isotopic weight of Pb^{206} would seem to have the surprisingly low value 205.90–205.93.

It is difficult to explain the difference in the atomic weights of the lead from the black and yellow portions of the original mineral. If the veins were formed by infiltration, an external source of lead of atomic weight 205.97 is required. If, as seems more probable to us, the yellow material is an alteration product, it might indicate a different rate of decay of uranium isotopes, as v. Grosse has recently proposed.[4] But since then the yellow material must contain on an average older lead than the black, this hypothesis would require a higher rate of decay for U^{238} than for U^{239}, a conclusion which is contrary to v. Grosse's.

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FREE POSITIVE ELECTRONS RESULTING FROM THE IMPACT UPON ATOMIC NUCLEI OF THE PHOTONS FROM TH C″

THE discovery of the fact that free positive electrons are present among the secondary particles resulting from the disruption of nuclei by the cosmic radiation,[1] together with various kinds of evidence that the primary cosmic radiation at sea-level consists largely of photons, made it appear of value to study the hard γ-rays of natural radioactive substances for similar effects. Experiments have been carried out which gave conclusive evidence that positrons[2] are ejected from lead by the γ-radiation of Th C″.

Near the bottom of a vertical Wilson cloud-chamber operating in a magnetic field of about 400 gauss a plate of lead was placed through which a collimated pencil of γ-rays from Th C″ was allowed to pass. About 5 cms above the lead was inserted an aluminum plate of 0.5 mm thickness for the purpose of differentiating between particles of positive and negative charge, a method previously used by the author and later by Blackett and Ochialini for the same purpose.

Out of 1,500 exposures three photographs were obtained, each one of which showed a positron ejected from the lead, the direction of ejection being nearly in the direction of the incident γ-ray beam. The positrons penetrate the aluminum plate and emerge with an appreciably lower energy; in all three photographs the tracks cross practically the whole chamber, and their curvatures are readily measurable and of the right order of magnitude. The general indications are that the positrons are not very rare among the electrons ejected from the lead.

These photographs offer unambiguous evidence that photons when absorbed by nuclei do eject both positive and negative electrons quite in accordance with the evidence which has appeared in cosmic-ray studies. Further, many of the tracks which we have obtained from the γ-rays of Th C″ resemble the showers such as those obtained by us[3] and particularly emphasized in the photographs of Blackett and Ochialini.[4]

I wish to express my gratitude to Mr. Seth H. Neddermeyer, for his assistance and to the Carnegie Corporation for their support of this whole program.

CARL D. ANDERSON

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METHOD OF EXTRACTION OF SUPRARENAL CORTICAL HORMONE-LIKE SUBSTANCE FROM URINE

IN view of the physiological significance of the possible presence of a substance in the urine that raises the resistance of suprarenalectomized rats to histamine poisoning,[1] the exact method of extraction of this substance is given below:

[4] *Phys. Rev.*, 42: 565, 1932.
[1] SCIENCE, 76: 238, 1932.

[2] The contraction positron is here used to denote the free positive electron.
[3] C. D. Anderson, "Cosmic-Ray Bursts," *Phys. Rev.*, 43: 5, 368, March 1, 1933.
[4] *Proc. Roy. Soc.*, 139, 699, 1933.
[1] D. Perla and J. Marmorston-Gottesman, *Proc. Soc. Exp. Biol. Med.*, 28: 1024, 1931.

The urine of young adult males and females is collected during the evening and night in large amber-colored bottles, packed in ice and containing a small cube of CO_2 snow; 50 cc of benzene is added to each bottle. A large funnel is inserted through an opening in the cork of the bottle, and the stem of the funnel is closed by a cork attached to a long glass rod. When in use this cork is removed and urine passed into the funnel. The cork is then immediately replaced. This method of collection results in a minimal amount of decomposition of the urine and keeps the freshly voided urine cold in an atmosphere saturated with CO_2 and under a layer of benzene. The following morning the bottles are removed to a dark room and the urine extracted with 50 cc of benzene for each liter of urine. An electrical mechanical mixer with a small fan-shaped stirring rod is used for agitation and extraction. The extraction with benzene is continued for from 10 to 15 minutes, and repeated with fresh benzene. The benzene is separated, and the fractions pooled and evaporated at 40° in vacuo to dryness. The residue is taken up in ether, the ether evaporated and the ether residue is shaken with the desired amount of physiological saline. The final aqueous product is colorless, has no odor of urine, turns faintly pink in 20 hours, and is non-irritating to rats when injected subcutaneously or intraperitoneally. The final product is made so that 1 cc of the extractive is equivalent to 300 cc of urine. The potency of such extracts will vary with the concentration of the original urine. The precautions employed in the collection of the urine minimize the effect of light and oxidation of the substance in the urine.

Although the substance obtained by the above method from urine raises the resistance of suprarenalectomized rats to histamine poisoning, as also does the life-prolonging hormone of the suprarenal cortex, proof is lacking that it is identical with the life-prolonging hormone.

DAVID PERLA
J. MARMORSTON

PRELIMINARY REPORT ON REDUCING TRANSPIRATION OF TRANSPLANTED EVERGREENS

IN the semi-arid Great Plains Region, coniferous evergreens are the most desirable shelterbelt trees and are the most permanent when once established. Unfortunately, their mortality in transplanting is particularly high, losses of 50 to 100 per cent. being not uncommon on prairie farms. Probable factors responsible for this loss are: (1) Climatic conditions favoring a high transpiration rate; (2) necessity of moving evergreens in full foliage; (3) slow rate of regeneration of roots destroyed in digging and resetting.

Since the fall of 1931 the Cheyenne Horticultural Field Station has been investigating means of reducing the transpiration rate of transplanted conifers. Through the work of Neilson[1,2] and others[3,4,5] the coating of dormant deciduous nursery stock for protection in storage, shipment and transplanting is being used to some extent in horticultural practise. Following the work of these investigators, various materials have been applied to the above-ground parts of dormant conifers in an attempt to cut down excessive transpiration of transplants until the damaged root systems can develop sufficiently to again support the trees.

Many materials have been tested, consisting chiefly of waxes, gums, resins, oils and asphaltic compounds, alone, and in various mixtures. Proprietary preparations employed included a rubber compound, a special petroleum wax, a Duco formula, a paraffin emulsion and four commercial nursery waxes. Early in the trials it was found that waxy materials which gave thick and nearly complete coverage of coniferous needles reduced transpiration almost to nothing; however, such heavy coatings caused severe injury to the plants. The temperatures at which materials can safely be applied to dormant evergreens is much lower than for dormant deciduous trees, but varies somewhat with different species, *e.g.*, Colorado blue spruce (*Picea pungens*) can not safely be treated with materials above 65° C., while yellow pine (*Pinus ponderosa*) can stand 5 to 10 degrees higher. Difficulty of securing thin coatings of waxy materials at these temperatures led to the use of pure oils and emulsions of oils and waxes which can be applied with a sprayer. Of the many oils tested, castor oil and corn oil were the only ones that did not injure the conifer needles when applied in pure form. Emulsifying some of the injurious oils greatly reduced or entirely removed their toxicity.

The non-toxic oils and several emulsions of oils and waxes have been tested on different typyes of conifers

[1] J. A. Neilson, "Paraffine Wax—an Aid to Growth in Transplanted Trees and Shrubs," *North. Nut Grow. Ass'n. Proc.*, 19: 44–51. 1928.

[2] J. A. Neilson, "Reducing Storage and Transplanting Losses in Nursery Stock" *Flor. Exch. and Hort. Trade World*, 78: (No. 5) 27, 35. 1931.

[3] C. N. Pillsbury, "The Use of Rubber in the Propagation, and for the Protection of Nursery Stock," *Flor. Exch. and Hort. Trade World*, 77: No. 17, 28–29, 41. 1931.

[4] H. B. Tukey and Karl Brase, "The Effect of Paraffining, Pruning and Other Storage Treatments upon the Growth of Roses and Cherry Trees, *Am. Soc. Hort. Sci. Proc.*, 28: 489–495. 1931.

[5] T. J. Maney, "An Apparatus for Spraying Plants with Melted Paraffin or Other Waxes," *Am. Soc. Hort. Sci. Proc.*, 28: 496–497. 1931.

without injury, and the efficacy of these coatings in reducing transpiration has been determined. The table shows a comparison of a few materials sprayed on uniform lots of five-year-old dormant pines.

PINE (PINUS AUSTRIACA)

	*Daily loss before treatment	†Daily loss after treatment
Corn oil	20.7 gms	2.4 gms
(1) Sulphonated linseed oil emulsion 33⅓ per cent.	20.8	8.4
(2) Crystal No-Dri 50 per cent. solution	20.7	18.0
Beeswax emulsion	20.9	18.3
Untreated (control)	20.3	26.3

* Averages for 8 days.
† Averages for 7 days.
(1) Prepared by heating 9 parts boiled linseed oil to 470° F. and adding 1 part flowers of sulfur to the hot oil. Emulsified by mixing with laundry soap and water.
(2) Manufactured and sold by the Crystal Soap and Chemical Co., Inc., Philadelphia.

The trees had been grown in pots long enough to be thoroughly established and to ensure that all were living. The pots were sealed in metal cans and the trees exposed to outdoor conditions. Trees were grouped into five lots of four trees each and transpiration (loss of weight) was determined every two days, water being added after each weighing to make good the loss. After a period of eight days during which the comparative transpiration rates of the five lots were determined, different treatments were applied to each lot and the loss in weight determined for seven more days, water loss being replaced as before. It will be noted that in the period before treatment the groups were selected so that their average daily transpiration rates were practically equal. After treatment the groups showed wide variation in water loss. The data show that all coatings reduced transpiration as compared with the untreated control, pure corn oil in this instance, causing a reduction of 88.4 per cent. Whether such a great reduction in transpiration is necessary or even desirable is not yet known, although no detrimental effects were noticeable after several months. Further investigations are under way to determine the ultimate effect of these coatings on the tree's metabolism.

In actual practise the materials are best applied by spraying seed beds or nursery rows before digging. Thousands of conifer seedlings and transplants have been treated this year with oils and emulsions, apparently with good results. It is believed that these coatings may also prove useful in protecting coniferous seed beds from excessive drying out over winter. In this connection the efficiency of the sulphonated oil is of interest, as this material is also a repellent for rodents that attack nursery beds.

A complete report of these investigations will appear in a later publication.

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